Increasing early surgery within 2 days for hip fracture: a time trend in 15 EU countries (2000-13)

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Abstract

Objective To analyse the trajectories of hip-fracture surgery rates within 2 days of admission to the hospital and the ratios of procedures initiated within the same day (day 0) and the following day (days 0–1) to procedures performed on the 2nd day. To study the association between socio-economic, health input variables and early surgery.

Design A pooled, cross-sectional, time series analysis was used to evaluate secondary data from 15 European countries, during 2000/2013.

Results The rate of patients aged ≥65 years that were operated on within 2 days of hip-fracture has changed over time with an EU average annual increase of 0.42% (95% IC = 0.25, 0.59; $P < 0.001$) and with a significant linear trend. Multiple slopes from all the countries compete with this result. In contrast, the ratios of procedures initiated within the same day (day 0) and the following day (days 0–1) compared to procedures performed on the 2nd day are constant.

No association was found between the rate of patients treated within 2 days of admission and demographic structure, health expenditure, health resources. However, the rate of patients treated within 2 days of admission is significantly associated with surgical volumes.

Conclusions

As the early surgery rate is growing, policy makers should be encouraged to undertake further policies to support the quality of care, and the providers should be driven to improve their organizational

effectiveness by taking actions aimed at acting on specific organizational and logistical causes that represent a barrier to early surgery.

Keywords: Quality improvement, Elderly, Hip fracture; Early surgery, Healthcare

INTRODUCTION

Osteoarthritis or hip fractures are diseases that, in most cases, require surgery to reduce pain and disability. The main risk factors for hip fractures are associated with ageing, including an increased risk of falling and loss of skeletal strength from osteoporosis. In a society with strong demographic change across most EU countries, with increasing life expectancy, and with an ageing population, there is a greater number of comorbidities (e.g., obesity), and the demand for hip replacement is growing and will become an important public health issue [1].

Many meta-analyses highlight that early and appropriate surgery for hip fractures is the most effective form of treatment for quickening rehabilitation, influencing mortality, reducing complications and improving quality of life at discharge [2,3]; the time taken to initiate hip fracture surgery after hospital admission is widely considered to be a clinically meaningful indicator of the quality of acute care received by patients with hip fractures [4].

Because surgical delay is associated with a significant increase in the risk of negative outcomes, clinical guidelines recommend immediate reparative surgery, within 24–48 hours following hospital admission [5,6]. Consequently, many European states (e.g., Italy) have adopted early operative models to improve the quality of care provided and to counter complications.

To the best of our knowledge, no study has been performed to analyse the performance and time trends of European healthcare systems, as assessed in terms of the early surgical response to patients with hip fracture. Therefore, the goal of this study is to analyse the trajectories of hip-fracture surgery rates across EU countries in patients 65 years and older. The specific objectives are to answer the following questions:

(a) How have the rates of hip-fracture surgery within 2 calendar days after admission to the hospital changed over the time?

(b) How has the ratio of procedures initiated within the same day (day 0) and the following day (days 0–1) compared to procedures performed on the 2nd calendar day after admission changed over the time?

(c) What association can be found between hip-fracture surgery within 2 days after admission to the hospital rate and socio-economic or health input variables?

METHODS

This study used a pooled cross-sectional time series analysis [7] of secondary data for 15 European countries over a 14-year period (2000 to 2013). These countries and years were chosen based on the availability of the data. The unit of analysis was each country in each year (country-year). The countries included in the study were the following: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, Germany, Ireland, Italy, Netherlands, Portugal, Slovenia, Spain, Sweden, and the United Kingdom.

All the indicators considered in this study were retrieved from the Organization for Economic Co-operation and Development (OECD) Health Statistics Database (year 2017), which offers freely available comparable statistics on health and health systems across OECD countries. Definitions of each item are listed in Table 1. All OECD indicators are measured over the population aged ≥65 years, except indicators #4 to #6 and #8 to #10, which are available for the entire population only. Waiting times for hip replacement surgery, as provided by OECD, were not analysed because of many missing values.

Statistical Analysis

First, a time trend analysis was performed using a fixed-effect regression on the annual proportion of hip-fracture surgery initiated within 2 days after hospital admission. We performed fixed-effect regression because the random-effects specification was found to be inappropriate for country-level effects by performing a Hausman test with the sigma more option [8]. An advantage of the fixed-effects models is that they control for time-invariant heterogeneity among countries [9]. The significance of the trend was assessed using robust standard errors due to results obtained from performing a modified Wald test for group-wise heteroscedasticity in the regression residuals [10].

We used the same approach to test whether the ratio of interventions initiated within the following day (days 0–1) to those performed on the 2nd calendar day after discharge (day 2), as well as the ratio of interventions performed on day 0 to those performed on day 2, significantly changed over time. However, due to the very limited number of countries for which this information was available (Belgium, Denmark, Estonia, Ireland, Netherlands, Spain, and United Kingdom), we estimated the standard errors using cluster bootstrapping with 1000 replicates for this analysis.

Second, we conducted a pooled, cross-sectional, time series analysis to assess the relationship between the proportion of hip-fracture surgeries performed within 2 days (that is, dependent variable) and a set of independent variables (indicators #4 to #10) over the 14-year study period. More specifically, we performed a fixed-effects linear regression with robust standard errors [10], and controlled for the presence of exogenous time trends in both the dependent and independent variables (i.e., time-fixed effects) by adding dummy variables to the model for each of the study years except the first year. We separately examined the relationship with each independent variable, resulting in 7 distinct fixed-effect models. This choice was driven primarily by concerns about model over-fitting and multi-collinearity. Due to the results obtained from performing the Hausman test, random-effects specification was preferred to the fixed-effects specification for 2 out of 7 indicators (#7 and #9) [8].

Fixed-effect models have been shown to deal generally well with unbalanced data and to get relative small improvements in the estimates and standard errors when a multiple imputation of missing data is used [11], so a list-wise deletion was used for all analyses. All data were analysed using the *Stata software package, version 13* (StataCorp. 2013, Stata Statistical Software: Release 13; StataCorp LP, College Station, TX, USA). The significance level was set a $P < 0.05$.

RESULTS

The percentage of patients aged 65 years and older that were operated on within 2 calendar days of fracture of the femoral neck between 2000 and 2013 are shown in Figure 1. The variability is marked.

In Southern Europe, the values were always between 25% and 60%, while in Central and Northern Europe, they were over 75%.

The EU countries rate changes with an EU average annual increase of 0.42% (95% IC = 0.25 to 0.59; $P < 0.001$), and the fixed-effects regression model shows that there is a significant linear trend. All the countries compete with this result, with multiple slopes. An average annual change of -2.4% and -3% draws the decreasing trend in Portugal and Estonia, respectively, whereas there is evidence of an increase in the other countries (Table 2), ranging between 0.13% to 0.64%. Italy shows an average annual change that is more important with an increase in the indicator between 2007 and 2013 of 2.88%.

The OECD health database contains specific data relating to hip-surgery within the same day or the following day after admission to the hospital for only seven countries (Belgium, Denmark, Estonia, Ireland, Netherlands, Spain, and United Kingdom).

Figure 2 shows that the ratio of procedures initiated within the following days (days 0-1) compared to the procedures performed on the 2nd calendar day after admission to the hospital is always above 1 in the observed period. This means that the number of procedures performed within the following day (days 0-1) is always greater than the number of interventions performed on the last day (day 2). The regression analysis emphasizes that there is no clear temporal trend ($b = 0.03$; $P = 0.792$; 95% CI = –0.19 to 0.25).

The results of the analyses carried out on the ratio of procedures initiated within the same day (day 0) compared to the procedures performed on the 2nd calendar day after admission to the hospital are similar. For five countries, the ratios are always above 1, and for Spain and the UK the number of procedures performed within the same day (days 0) is always lower than the number of interventions performed on the last day (day 2). The regression analysis emphasizes that there is no clear temporal trend ($b = 0.04$; $P = 0.452$; 95% CI = –0.06 to 0.14).

Table 3 shows the results of the regression analysis, which assesses the impact of the demographic structure, health expenditure, health resources and surgical volumes on the timeliness of surgery

following hospitalization due to hip fracture. The only significant result concerns the number of surgical procedures for hip replacement: a one-unit increase in hip replacement surgery for every 1000 inhabitants aged ≥65 is associated with a 1% increase in the proportion of patients treated surgically within 2 calendar days of hospitalization. This evidence is confirmed when the standard error (SE) and confidence interval of the regression coefficient are estimated with the bootstrap method (b = 1.00; SE = 0.51; 95% CI = 0.05 to 0.36).

DISCUSSION

To the best of our knowledge, this is the first study aimed at analysing the rates of hip-fracture surgery within 2 calendar days after admission to the hospital in 15 European countries with a goal of describing the annual variations from 2000-2013, determining whether these changes are constant over time, and systematically analysing the association between economic factors and rates of hip-fracture surgery within 2 days. In addition, analysing the ratio of procedures initiated within the same day (day 0) and the following day (days 0–1) compared to the procedures performed on the 2nd calendar day after admission to the hospital.

There are a number of aspects of this study that must be considered before the implications of the findings can be discussed. The main limitations are related to the database and are common to the largest database studies. First, evidence from OECD projects indicates problems related to the quality of the data on the hip, especially with regard to the limited availability over the time and the reliability of the data. Second, the nature of the data is such that only calendar days could be noted; therefore, it is not possible to quantify surgical delays on an hourly scale. Therefore, because the data on the hip fracture surgery were initiated within 2 calendar days, including the cases that were treated on day 0 (same day as admission), treated on day 1 (next day) and treated on day 2, this study partly refers to patients operated on between 48 and 72 hours, with an overestimation of the rates. Third, the aggregated data for countries inevitably conceal large variations in terms of the socio-demographic variables, or other factors, such as the hospital status or size of the hospitals. Indeed, Petrelli [12]

observed the role played by socioeconomic status in delaying hip fracture surgery in Italy with statistically significant differences on access to earlier surgery between people with a lower and higher level of education. Elkassabany [13] showed that the odds of surgical delay over 2 days was higher among Medicare beneficiaries that were admitted to larger hospitals (≥200 beds) and teaching hospitals in comparison with patients admitted to non-teaching hospitals and small or medium sized centres (< 200 beds).

Our results show that hip-fracture surgery performance within 2 days of admission to the hospital in 15 European countries is improving over the time and is constantly increasing. This means that attention is being paid to improving the quality of health care. Twelve UE countries experienced a significant increase on rates, although at different annual changes (slopes). The highest EU average annual rate increase is shown in Italy, and it may be explained by the fact that, for years, the Italian health system has aimed at ensuring the appropriate use of resources and ensuring the balance of the budget. In this context, some health laws establish that physicians conform their own decisions to the clinical pathways (PDTAs) defined by evidence. The Essential Levels of Assistance (LEA) verification Committee identifies the clinical pathway of hip fracture in the elderly as an instrument able to guarantee the appropriateness, timeliness and efficiency of the treatment path [14]. The National Agency of Regional Health Services has constructed a series of indicators known as Outcomes National Program which evaluated quality of care among hospitals and the results of this assessment have been systematically used to improve care quality and performances. In addition, the regional policy makers induce the correct management of the path of elderly persons with femur fractures, an objective which correlates with the additional remuneration of general managers.

The results from Estonia and Portugal are in contrast with the quality and appropriateness of hip surgery within 24–48 hours following hospital admission recommended by the clinical guidelines.

One possible explanation for the significant reduction in Estonia's rates is provided by the literature, which highlights the importance of having a quality measurement tool in which indicators are used by a provider to facilitate both organizational performance improvement and systems management

and, at the same time, are used by policy makers to select the best care providers [15]. Since 2001, Estonia has taken measures in these directions but with limited success. Indeed, performance indicators are regularly published for all the hospitals of the Hospital Network Development Plan; however, these indicators do not include any indication of earlier intervention [16]. Similarly, with the objective of selecting the best service providers, quality criteria have been defined, but, in 2013, they were not yet in use for selection [17].

Literature, agencies and organizations agree that clinical practice guidelines, which are systematic statements that assist practitioners and patient decisions, are helpful in framing strategies to improve care [18,19] and that clinical pathways have been designed to provide an effective interface between evidence and practice in healthcare. Strong evidence supports the assertion that the utilization of clinical pathways improves outcomes [20]. Estonian health system is late in adopting guidelines that were on the agenda in 2010. Additionally, clinical pathways have been developed for cancer but are underdeveloped for the other conditions and diseases [21].

The rate of hip fracture surgery within 48 hours has reduced in Portugal over the time. This result was achieved despite the fact that Portugal has undergone important health-related reforms over the past two decades oriented towards the pursuit of patient safety through economic manoeuvres, such as quality-based payment, of which one indicator is the rate of hip surgical operations performed within 48 hours [22]. It is likely that financial incentives linked to the quality of hospital services stopping at 5% of the hospital income [23] are not able to impact early surgery.

Another explanation can be drawn from social inequalities. A study by Cookson et al. identified how only 65% of the general health care costs are publicly financed and indicates how the poorest areas have privileged access to hip replacements in publicly funded hospitals [24]. Because the data analysed include only private and public surgical activity that is financed by public funds and not privately funded, it is likely that, in the wealthier areas, there is a shift in the surgical activity demand towards privately funded activity.

The increase in the rate of procedures that started within 2 calendar days is accompanied by constant ratios of procedures initiated on the same day (day 0) and the following day (days 0–1) compared to procedures performed on the 2nd calendar day after admission to the hospital. While considering that surgery may be delayed by medical complications or because of the need to stabilize patient conditions prior to surgery, it seems that further reducing intervention times is difficult for health systems.

A significant result of this study is the relationship between surgical volumes and early hip fracture treatment, showing that when increasing surgical volumes, there is an increase in the rate of patients treated within 2 days of admission. This result may be justified, and the literature agrees that, in addition to medical causes, the reasons for operating delay can be logistical and organizational [25]. The logistical causes relate to the availability of operating rooms [25–27], the availability of surgeons and other surgical personnel [26], the availability of anaesthesiologists and the availability of equipment [25]. The organizational causes include waiting for medical consultation or clearance [27]; waiting for laboratory results and other diagnostic results [25,26]; the preferences of the orthopaedist, surgeon and anaesthesiologist in prioritizing patients on the surgical waiting list [27]; and poor ward management [25]. These cause system-related issues, suggesting that high-volumes of patients drive the health system and hospital to seek organizational effectiveness, which is understood as the organization ability to achieve the outcomes the organization intends to produce [28] in several key areas, including changing the organization design and structure, deploying smart processes, and managing human capital to identify an organizational model able to optimize and improve the productivity of the health care settings. This suggestion is supported by Elkassebany [13], concluding that better inpatient processes are in high volume hospitals.

This study allows some preliminary conclusions and deducing some implications.

First, there is evidence of a growing linear trend in hip fracture surgery within 2 calendar days in EU countries over the period between 2000-2013; second, health systems do not seem to improve their

performance by reducing the intervention times to the same day or the day after admission; third, high-volumes play a positive role in achieving further gains in performance improvements.

The implications involve various stakeholders. First, policy makers should be encouraged to undertake further policies to support the quality of care, where one of the key goals may be that medically fit patients with hip fractures may be operated on within 2 days after admission to the hospital and to introduce the performance assessment of hospitals using fracture surgery within 48 hours as a quality benchmark [29].

The providers should be driven to improve their organizational effectiveness through the analysis of the organizational model present to determine the types of delay and take actions aimed at the specific organizational and logistical causes that represent a barrier to early surgery. In this regard, the literature already offers strategies to remove the most commonly documented causes of operational delay, such as education, peer review, and multidisciplinary approaches [30], which are included in successful strategies for reducing physician-caused delay, including the surgeon and anaesthesiologist [29].

Finally, in light of the results from a previous study [31], a significant improvement in early surgery can be made by the multidisciplinary efforts of anaesthesiologists, surgeons and nurses, and the professionals should be responsible for reducing surgical delay.

The joint action of the various participants represents the appropriate tool to guarantee the appropriateness of the treatment path to match the time limit suggested by the guidelines.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no competing interests.

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TABLES

Table 1. OECD Health Statistics 2017 indicators and definitions.

#	Indicator	Definition
1	Hip-fracture surgery within 2 days	Proportion of hip-fracture surgery initiated within 2 calendar days after admission to the hospital (days 0–2), patients aged ≥65 years (%)
2	Hip-fracture surgery within 1 day	Proportion of hip-fracture surgery initiated within the following day after admission to the hospital (days 0–1), patients aged ≥65 years (%)
3	Hip-fracture surgery within the same day as admission	Proportion of hip-fracture surgery initiated within the same day after admission to the hospital (day 0), patients aged ≥65 years (%)
4	Total expenditure on inpatient curative and rehabilitative care	Total expenditure on inpatient curative and rehabilitative care, per capita, constant prices, constant PPPs, OECD base year (2010 US Dollars, in hundreds)
5	Public expenditure on inpatient curative and rehabilitative care	Public expenditure on inpatient curative and rehabilitative care, per capita, constant prices, constant PPPs, OECD base year (2010 US Dollars, in hundreds)
6	Rehabilitative care beds	Number of hospital beds available for rehabilitative care, per 100 population
7	Hip replacement surgery	Number of urgent and elective hip replacement procedures, per 1000 population aged ≥65 years
8	Publicly owned hospitals	Number of public owned hospitals, per million population
9	Not-for-profit privately owned hospitals	Number of not-for-profit privately owned hospitals, per million population
10	For-profit privately owned hospitals	Number of for-profit privately hospitals, per million population

Abbreviations: OECD, Organization for Economic Co-operation and Development; PPP, purchasing power parity.

Table 2. The percentage of hip-fracture surgeries initiated within 2 calendar days after hospital admission (%) for ≥65-year-olds in 15 European countries, first and last available year.

Country	First available %	Last available %	Observation period	Average annual change	*P*
Austria	81.9	84.4	2005/13	0.31	0.001
Belgium	80.6	84.3	2000/11	0.34	0.009
Czech Republic	84.5	85.4	2009/13	0.23	0.086
Denmark	92.4	95.8	2006/13	0.49	0.004
Estonia	89.9	80.9	2010/13	–3.00	0.017
Finland	77.5	85.8	2000/13	0.64	0.001
Germany	84.6	87.6	2008/13	0.60	<0.001
Ireland	80.6	82.3	2000/13	0.13	0.082
Italy	27.5	44.8	2007/13	2.88	0.004
Netherlands	90.1	95.2	2000/11	0.46	<0.001
Portugal	57.0	45.0	2008/13	–2.40	0.130
Slovenia	57.0	61.9	2009/13	1.23	0.023
Spain	38.1	43.3	2000/13	0.40	0.009
Sweden	90.7	93.0	2008/13	0.46	0.029
United Kingdom	82.6	87.6	2000/13	0.38	0.007

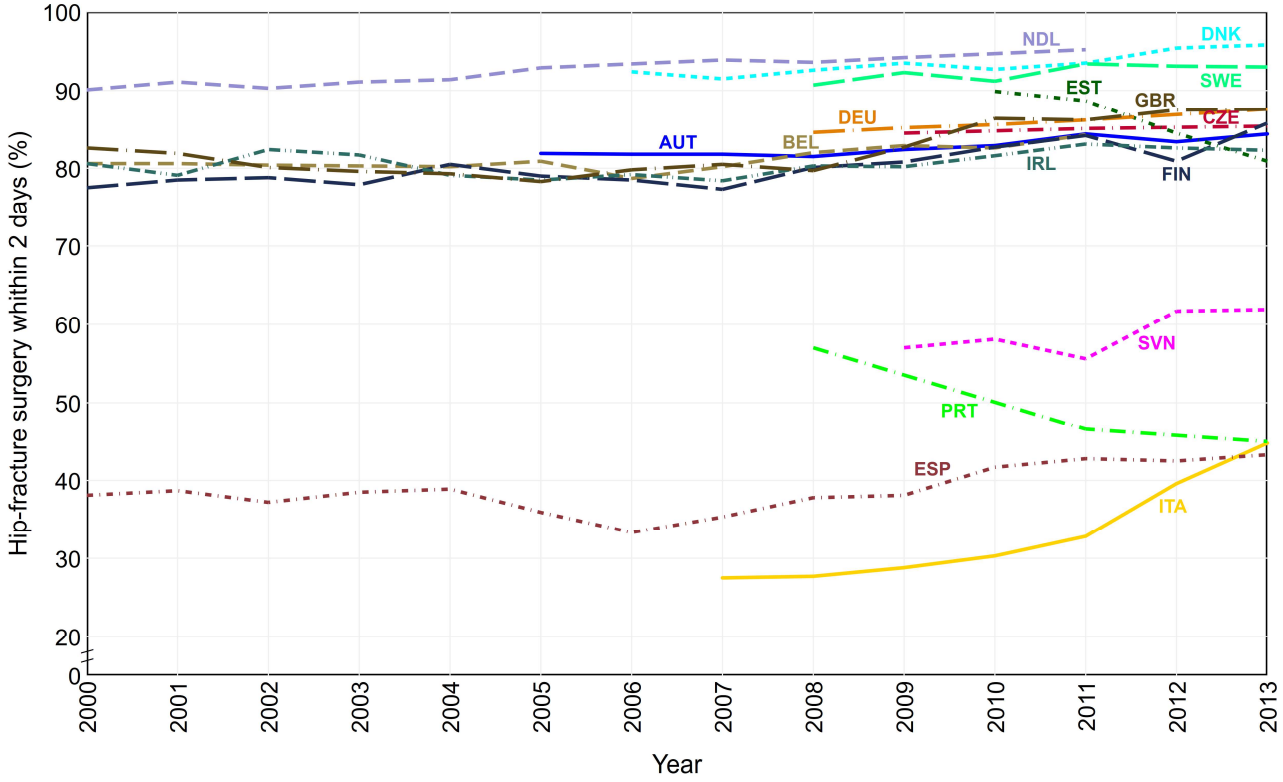
Table 3. Results of regression analysis on hip fracture surgery within 2 calendar days (%).

Independent variable (unit of measurement)	Effect size		Time effect		R^2	Countries	Average obs. per country
	b	SE	*F*-statistic	*P*			
Total expenditure on inpatient curative and rehabilitative care (hundreds of $)	0.24	0.60	1.68	0.088	0.988	12	7.5
Public expenditure on inpatient curative and rehabilitative care (hundreds of $)	0.78	0.93	1.21	0.296	0.988	12	7.5
Rehabilitative care beds (per 100 population)	–1.11	0.57	2.11	0.029	0.983	11	7.0
Hip replacement surgery (per 1000 population aged ≥65 years)	1.00*	0.40	57.37	<0.001	0.983	15	8.0
Public hospitals (per million population)	0.03	0.07	1.55	0.133	0.982	10	7.5
Not-for-profit private hospitals (per million population)	0.22	0.61	7.88	0.851	0.981	9	6.8
For-profit private hospitals (per million population)	0.12	0.56	1.47	0.168	0.980	11	6.4

* Significant at the 5% level.

Abbreviations: SE, standard error.

Figure 1. Proportion of hip-fracture surgery initiated within 2 days after hospital admission (%) for ≥65-year-olds in 15 European countries (2000 to 2013).



Note: Missing data within the time-series of Czech Republic (2010, 2012), Germany (2012) and Portugal (2009, 2010, 2012) were interpolated by connecting the lines between the non-missing data points.

Abbreviations: AUT, Austria; BEL, Belgium; CZE, Czech Republic; DEU, Germany; DNK, Denmark; EST, Estonia; FIN, Finland; IRL, Ireland; ITA, Italy; NDL, Netherlands; PRT, Portugal; SVN, Slovenia; ESP, Spain; SWE, Sweden; GBR, United Kingdom.

Figure 2. Ratio of procedures initiated within the following day (days 0–1) to procedures performed on the 2nd calendar day after discharge (day 2) for ≥65-year-olds (2000 to 2013). Information available for 7 European countries.